

CIREN

Crash Injury Research and Engineering Network
The NHTSA Learning Laboratory for Lifesaving



Engineering
Prevention



Medical
Treatment



Serious Injury Crashes



People Saved



Transport to
Trauma Centers



Safer Cars



Serious
Injuries



Smarter Crash
Dummies



Improving
Emergency
Medical Care



Better Treatments



Technical Report Documentation Page

1. Report No. DOT HS 809 564		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle NHTSA Crash Injury Research and Engineering Network (CIREN) Program Report, 2002				5. Report Date June 2003	
				6. Performing Organization Code	
7. Author(s) NHTSA and CIREN Center Staffs				8. Performing Organization Report No.	
9. Performing Organization Name and Address National Highway Traffic Safety Administration (NHTSA) Advanced Safety Research (NPO-110) 400 7th St. S.W. (Room 6220) Washington, DC 20590				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No.	
12. Sponsoring Agency Name and Address National Highway Traffic Safety Administration U.S. Department of Transportation 400 7th Street, S.W. Washington, DC 20590				13. Type of Report and Period Covered Program Report, 2002	
				14. Sponsoring Agency Code	
15. Supplementary Notes This report was edited by Louis V. Lombardo, NHTSA					
16. Abstract The National Highway Traffic Safety Administration has created the Crash Injury Research and Engineering Research (CIREN) program for the purpose of conducting multidisciplinary research on serious crash injuries. The mission of CIREN is to improve the prevention, treatment, and rehabilitation of motor vehicle crash injuries to reduce deaths, disabilities, and human and economic costs. The goal of NHTSA/CIREN research is to identify opportunities for improvement in the prevention and treatment of crash injuries. This is accomplished through coordinated efforts of medical and engineering researchers. This report provides a description of the NHTSA CIREN Network, each of the 10 CIREN centers, the research teams, and their work. The report summarizes the contributions to auto safety produced by NHTSA CIREN center researchers.					
17. Key Words Crashes, Injuries, Medical and Engineering Research, Trauma, Biomechanics, Crash Investigation, EMS, Helicopter Rescue, Automatic Crash Notification, URGENCY, Child Safety, Costs of Injuries.			18. Distribution Statement This document is available to the public from the National Technical Information Service, Springfield, VA 22161 http://www.ntis.gov It is also available on the NHTSA web site at www.nhtsa.dot.gov and, on CD, from the National Crash Analysis Center, Ashburn, VA, 20147, Tel. 703 726 8236.		
19. Security Classif. (of this report) None		20. Security Classif. (of this page) None		21. No. of Pages 113	
				22. Price	

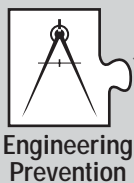
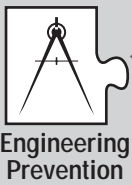


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CIREN Program Report, 2002

National Highway Traffic Safety Administration (NHTSA)

Introduction

This is the second NHTSA CIREN Program Report. The report provides a description of the research conducted by CIREN center multi-disciplinary research teams. CIREN research teams consist of trauma surgeons, emergency physicians, medical examiners, trauma nurses, epidemiologists, crash investigators, engineers, sociologists and computer data analysts.

The medical members of the team study the injuries, treatments and outcomes. The engineers study the crashes, vehicles, safety equipment, occupant kinematics and injuries. CIREN multidisciplinary research provides NHTSA, the auto safety engineering community, and the medical profession with the ability to jointly study “real-world” cases of serious injuries.

The individual centers have been operating for varying periods of time. While some current CIREN centers were performing hospital crash injury studies prior to the formation of CIREN, others have been established more recently.

CIREN researchers are key contributors to the Agency’s study of the medical and engineering aspects of serious crash injuries. CIREN “hands on” studies of crashes, injuries, treatments, and outcomes examine better ways to prevent and treat serious crash injuries. CIREN provides the safety community with a high-powered scientific “microscope” for the study of these crash injuries in the real world, and in near real time—in part, through regular public meetings.

NHTSA’s CIREN program works to increase the discovery, development, and delivery of improvements in the prevention and treatment of serious crash injuries.

The Safety Problem: Deaths, Disabilities, and Human & Economic Costs

The magnitude of the safety problem that the CIREN program addresses is summarized in national crash statistics. Every year there are nearly 42,000 crash deaths (almost half of the victims die without transport to a medical treatment facility) [1], 250,000 life-threatening injuries [2], 500,000

hospitalized [3], 2,000,000 disabled by injuries [4], and 4,000,000 emergency department visits [5]. Annually in America, motorists are involved in nearly 17 million crashes involving nearly 28 million vehicles [6]. Each year crash injuries result in approximately \$145 billion in economic costs, or \$340 billion in comprehensive costs that include value for pain and suffering [7]. These figures do not include costs of crashes due to property damage and traffic delay.

The CIREN Mission
The mission of the NHTSA Crash Injury Research and Engineering Network (CIREN) is to improve the prevention, treatment, and rehabilitation of motor vehicle crash injuries to reduce deaths, disabilities, and human and economic costs.

Since the advent of the automobile, more than 3 million people have been killed and 300 million injured in vehicle highway crashes in America – more than 3 times the number of Americans killed, and 200 times the number wounded, in all wars since 1776 [8].

If the current rate continues, NHTSA has projected that the current toll of 42,000 crash deaths each year could increase by 50 percent by 2020. [3]

Many of the people killed in crashes are young. Half are under age 34, and the average is 40 years of age for all crash deaths [1]. As the U.S. population ages, the average age of crash deaths is also increasing. The population of Americans over age 65 will increase from 34 million to 53 million by 2020 [3]. Crash fatalities and serious injuries have devastating physical and financial impacts on families. Many children, uninjured physically in crashes, are hurt in other ways such as loss of one or both parents, grandparents, siblings, or other loved ones. No count of this tragic toll on children is kept, but serious crash injuries often result in long-term physiological, psychological, and sociological consequences. Crash deaths and disabilities often have devastating impacts on individuals, families, and society.

Motor vehicle crashes cause large numbers of life-threatening and disabling injuries. National estimates for the number of serious crash injuries occurring each year during the 1995–97 period [9] are given below:

- 70,000 Brain Injuries
- 4,400 Neck and Spinal Cord Injuries
- 80,000 Chest & Abdominal Injuries: Heart, Lungs, Spleen, Liver, & Kidneys

- 18,000 Hip and Pelvic Injuries
- 35,000 Leg, Ankle and Foot Injuries

The above statistics are for serious injuries based on data from light vehicle towaway crashes and do not include a much larger number of less serious injuries occurring each year. Nor do these statistics include injuries to pedestrians, motorcyclists, and heavy truck occupants, for which statistics on serious injuries are not available in the NASS database.

The \$145 billion in economic costs for crash injuries incurred each year is comparable with the \$172 billion in costs for cancer and the \$350 billion in costs for heart disease. The annual federal budget for highway safety research however is \$205 million, compared to \$5 billion for cancer research and \$2 billion for heart disease research. [7, 18–21]

“Science begets knowledge.”

Hippocrates, 460-377 BC

The CIREN Program: Research to Reduce Fatal and Serious Injuries in Crashes

The NHTSA CIREN Program focuses medical and engineering research on finding ways to reduce crash deaths and critical injuries that have life altering consequences. CIREN researchers are working to improve both the prevention and treatment of crash injuries. Through CIREN research, NHTSA is examining questions of life and death importance for many Americans such as:

- Why do 20,000 people, nearly half of all crash fatalities, die each year without being taken to a medical treatment facility?
- How can we do a better job of getting seriously injured people the correct level of medical care they need – in time to prevent deaths and disabilities?
- What information will help the emergency medical system work “faster and smarter” in providing optimal care and delivering seriously injured crash victims to trauma centers?
- How do we learn to better evaluate crash data to improve patient outcomes?
- How can new safety and communications technologies be used to improve triage, transport, and treatment decisions?
- How do we develop new medical protocols to assure widespread deployment for improved triage, transport, and treatment of seriously injured crash victims?
- How do we educate and train the emergency medical care community to apply the latest lifesaving techniques for improved care of seriously injured crash victims?

- As air bags, belts and child seats save more lives each year, what are the residual injuries and their consequences?
- How, and to what extent, are new safety technologies working to save lives and reduce disabilities?
- To what extent can we reduce lifetimes of suffering from brain and spinal cord injuries through improvements in prevention and treatment?
- What biomechanics research can be done to prevent potentially fatal thoracic, and hip injuries?
- What can be done to prevent leg, ankle, and foot injuries and their resulting disabilities?
- How do we improve detection and treatment of traumatic brain injuries when diagnostic imaging studies often reveal negative clinical findings for lesions, but adverse behavioral consequences later become manifest?

CIREN Research – Serious, or compelling, injuries are characterized by their severity, i.e., requiring urgent or specialized critical care to prevent death and disability. In their work investigating serious crashes, injuries, treatments, and outcomes, CIREN researchers are producing a growing body of data and scientific research. Over the past decade, the CIREN Centers have published more than 100 scientific research papers in national and international medical and engineering journals. [10]

“Injury is not an insoluble problem. Exciting opportunities to understand and prevent injuries and reduce their effects are available.”

Injury in America, 1985

The CIREN Program, through 2002, now has a database of 1,752 cases of people involved in serious injury crashes. Among these are 1,180 cases of people suffering serious injuries, and 218 cases where the vehicle occupant ultimately died with the balance of the cases involving injuries of lesser severity.

CIREN Study Criteria – CIREN cases involve people so severely injured in motor vehicle crashes that they must be transported to a Level 1 trauma center. Case selection criteria are listed in Table 1.

Inclusion criteria also permit addition of any case of special interest. Beginning in 2003, more rollover crashes will be included as the two quarter turns limit will be removed.

The CIREN study case inclusion criteria were formulated to enable medical and safety engineering researchers to focus on the injuries that are most threatening to people's lives. Currently, case selection is restricted to restrained (air bag and/or belts) occupants.

Table 1. CIREN Case Inclusion Criteria for 2002

Crash Type	Crash Direction	Vehicle Year	Restraint Used	Occupant	Occupant Position	AIS Severity
Frontal	10 to 2 o'clock PDOF full or offset	LMY	AB, B, AB+B, CRS	Child/ Infant	Front	AIS>=1
					Rear	AIS >=2
				Adult	Front	AIS>=3*
Side, Near	8 to 10 2 to 4	1993 or later	Any and all	Child/infant	Any	AIS>=2
				Adult		AIS>=3*
Rear	4 to 8	1985 or later	rear-facing CRS	Infant only	Any	AIS>=2
Rollover	<= two quarter turns	LMY	AB,B, AB + B, CRS	All	Any	AIS>=2
Fire	All	LMY	N/A	All	Any	AIS>=2
All	All	All	CRS 1990 or later	Child/infant	Any	Any

Legend:

A: Airbag

B: Seat Belt

CRS: Child Restraint Seat

LMY: Late Model Year (the current year less 6)

PDOF: Principal Direction of Force

*or 2 or more AIS>=2 and of medical significance, or one or more AIS>=2 disabling injuries to the ankle or foot.

Abbreviated Injury Scale (AIS) is used to classify injuries generally according to their degree of severity based on threat-to-life. The AIS classification scale is as follows:

AIS 1 - Minor AIS 2 - Moderate AIS 3 - Serious AIS 4 - Severe AIS 5 - Critical AIS 6 - Maximum

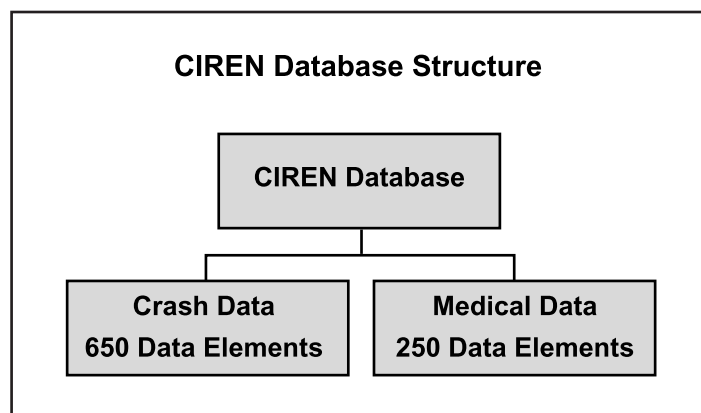
CIREN Data – The CIREN database consists of the NASS CDS set of 650 data elements plus an additional 250 medical and injury data elements. The NASS CDS data set contains variables that describe an automotive crash such as:

- Crash Type
- Vehicle Make, Models, and Body Types
- Collision deformation classification (CDC)
- Crush Profiles
- Delta Vs
- Intrusions
- Occupant Contacts

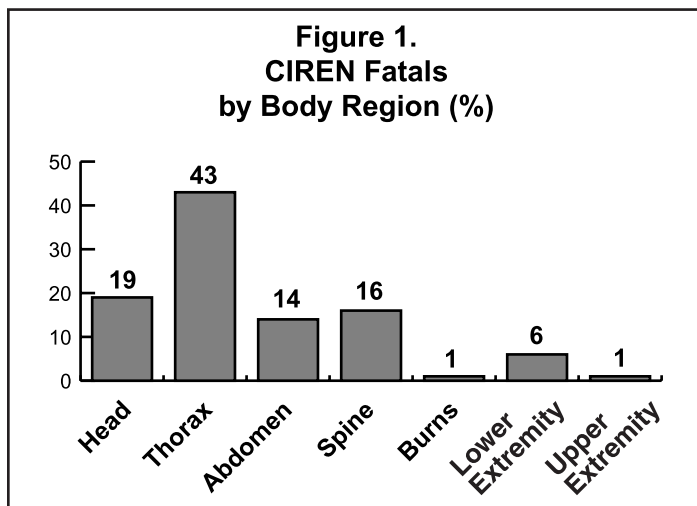
The CIREN medical and injury data elements include tables for:

- Co-morbidity
- Diagnostic Procedures
- Complications
- Operative Procedures
- Medical Images
- Disability Measurements

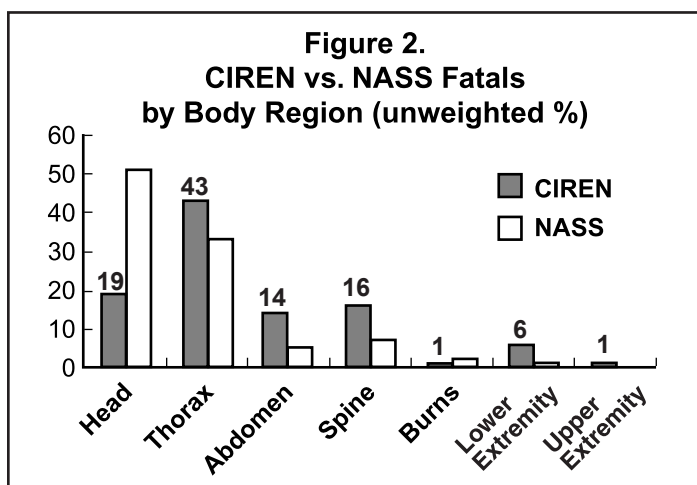
- Emergency Medical Response
- Emergency Medical Treatment
- Vital Signs
- Physiologic Measurements
- Injury Location
- Ventilation Periods
- Intensive Care Unit Stays



CIREN Cases – CIREN researchers now have detailed data on 218 people who ultimately expired from their injuries in crashes compiled from 1996–2002. Figure 1 shows the distribution of fatalities in CIREN by the body region where the most serious injury was located. Injuries to the thorax, head, spine, and abdomen were the leading primary causes of death in fatal CIREN cases.



CIREN and NASS – Figure 2 shows how the distribution of CIREN fatal cases by body region currently compare with the distribution of all fatalities in NASS. The proportionally fewer fatalities associated with head injuries in CIREN, in part, is due to the effects of CIREN case selection criteria differing from NASS. Specifically: (a) CIREN cases are limited to restrained occupants protected by air bag and/or belts, (b) in late model year vehicles with the latest safety features, and (c) crash victims have access to the highest quality emergency medical care at CIREN facilities which are Level 1 Trauma Centers. In contrast, NASS cases are statistically representative of all occupants (both restrained and unrestrained), in all model year vehicles.



The CIREN Centers have conducted research on more than 1,000 life-threatening injuries that did not result in

fatality, but are significant in the level of threat to life and/or long-term consequences.

These serious injury studies provide insights on potential improvements in prevention and treatment. Figure 3 shows the distribution, by body region, of compelling injuries in the CIREN database. The distribution shows that these compelling injuries in crashes are occurring primarily to the head, thorax, and lower extremities.

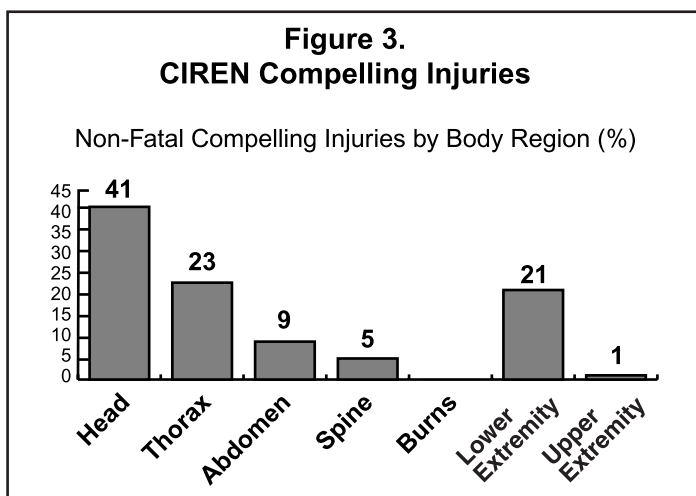
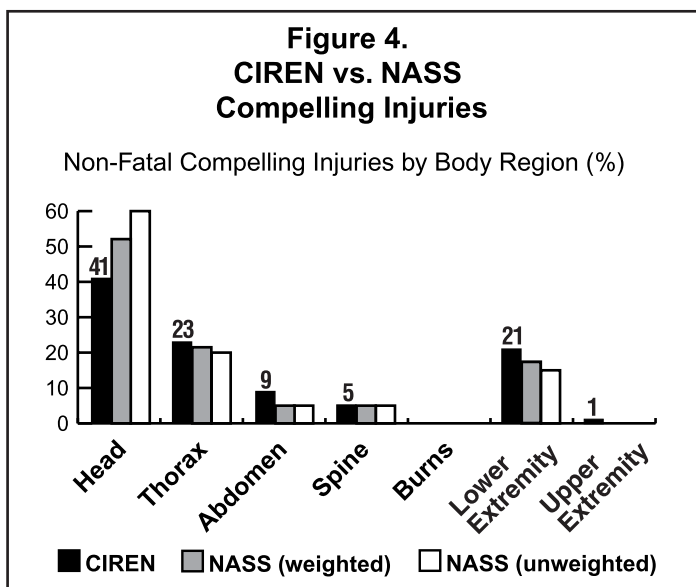


Figure 4 shows that the distribution of non-fatal compelling injuries treated at CIREN Centers is closely tracking the non-fatal compelling injuries being found in NASS. Thus CIREN is studying precisely the types of serious crash injuries that are occurring nationally – and doing so, in near real-time as the injuries are being treated. This illustrates how CIREN complements NASS.



CIREN is not a nationally representative sample of all crash injuries. It is designed to be a high powered tool for conducting research on serious injuries. CIREN is used to both generate and examine hypotheses through detailed studies of serious crashes, injuries, treatments, and outcomes.

CIREN is a complementary tool to NASS. NASS provides estimates of the broad national incidence of all crash injuries.

Thus, for example, CIREN may have more crashes of a particular crash type than would be obtained under case selection criteria designed to create a nationally representative sample of all crash injuries. The CIREN case selection process has the strength of being able to detect — early on — new serious injury patterns, and studying them in great detail.

CIREN studies injuries to people who have suffered a wide variety of injuries ranging in severity from moderately life-threatening to fatal. NHTSA estimates that out of a total 5,300,000 people injured each year in crashes, about 650,000 people suffer moderately life-threatening to fatal injuries each year. More than 95 percent of the injured people in CIREN cases suffered such serious injuries. The injuries specifically studied by CIREN represent 12 percent of all crash injuries, but because of their seriousness, result in about 77 percent of the total economic costs of crash injuries. These serious injuries, being studied by the NHTSA CIREN research program, nationally incur about \$112 billion in economic costs each year.

The work process employed by CIREN researchers has involved the following steps:

1. Observations of potential injury patterns at the CIREN center
2. Examination of NASS files to develop estimates of national incidence
3. Recommendation of potential next steps in continuous improvement cycles that have improved:
 - a. data collection, storage, and analysis e.g., crash investigation, data elements, and software
 - b. test equipment such as crash test dummies e.g., load measurement capabilities in the THOR dummy for acetabular and abdominal injuries
 - c. biomechanical injury criteria and test configurations, e.g., for knee, thigh, and hip injuries
 - d. standards for the protection of lower extremity injuries e.g., THOR Lx
 - e. air bags with features to lower deployment injury incidence
 - f. EMS triage, transport, and treatment decision-making capabilities with URGENCY software to help distinguish the one crash with high probability of serious injuries from the 100 crashes without serious injury.

The ten CIREN Centers bring to the nation the benefits of a broad geographic distribution of serious crash injury problems relating to vehicles, environmental conditions, roadways, driver behaviors, and medical practices. The CIREN researchers, some of the nation's foremost traumatologists

from a variety of specialties, bring a wide diversity of injury experience and medical and engineering expertise. They apply their rich multidisciplinary expertise to the many serious crash injuries they treat in their facilities and share their knowledge with NHTSA and the wider safety community. This combination of major medical facilities and researchers provides NHTSA and the safety community with a powerful microscope for the study of the prevention and treatment of serious crash injuries.

CIREN Research Progress

CIREN researchers continue to study the safety benefits of occupant restraint systems (air bags, seat belts, and their combination). New vehicles are increasingly being equipped with safety features such as: air bags with multi-stage deployment capabilities; safety belts with crash tensioning retractors, adjustable anchorage points; and belt force limiters. Because CIREN researchers study serious injury crashes, the vehicles, the resulting injuries, treatments, and outcomes; they are able to document both safety technology successes as well as needed improvements in prevention and treatment.

CIREN research is leading to improved understanding of the changing patterns of serious crash injuries. This research is leading to recognition of successful safety technologies and opportunities to improve both the engineering of safer vehicles and the medical treatment of seriously injured crash victims.

CIREN research is showing the benefits of:

Improving Safety Research:

Over the years, through both papers and presentations, CIREN researchers have brought to the safety community's attention the need for greater attention to several important aspects of improving the prevention and treatment of injuries:

- The importance of long-term consequences and costs of serious injuries such as brain and spinal cord injuries on individuals, families, and society. [Siegel, Augenstein, Burgess, Cushing, et al.]
- The significance of lower extremity injuries that may have a low threat-to life but high costs and life-long consequences for quality of life in pain and suffering. [Siegel, Augenstein, Burgess, Cushing, et al.]
- The many particular problems that occupant age, gender and habitus (young and old) present biomechanically and medically to reducing deaths and disabilities from crash injuries. [All Centers]
- The need for improvement in measures of injury burdens beyond AIS threat to life scales and economic costs. [Burgess, Siegel, et al.]
- The value of long-term follow-up outcome studies. [Siegel, Burgess, Cushing, Dischinger, Read, et al.]

Improving Auto Safety:

- Air bags reducing the incidence and severity of brain injuries [Siegel, et al.]
- New air bag designs reducing aggressive deployments [Augenstein, et al.]
- 3-point belts in rear seats to better protect children and adults from lethal abdominal injuries and crippling spinal cord injuries [Eichelberger, et al.]
- Safer child seats and their proper installation and use [Eichelberger, et al.]
- Safer vehicle structures to protect people from leg and hip injuries in frontal offset crashes [Burgess, et al.]
- Safer air bags and belts designed to protect older people in frontal impact crashes [Augenstein, et al.]
- Safer vehicle structures and side air bags designed to protect the head, thorax, and pelvis in side impact crashes [Mock, et al.]

“Serious crashes happen every day, more than half of them in rural areas where the ability to rapidly contact 9-1-1 and the capability of responders to quickly reach the scene can mean the difference between life and death. New technologies such as wireless E9-1-1, automatic collision notification and emergency vehicle route navigation are available that will make emergency access more reliable and help deliver faster and better emergency care.”

NHTSA Administrator Jeffrey W. Runge, MD

Improving Emergency Medical Care:

- Saving lives by faster and more accurate diagnoses and treatments of crash injured occupants [All CIREN Centers]
- Improving diagnostic tools to recognize occult, or hidden, internal injuries – especially for vehicle occupants who are older, female, of short stature, or large girth
- Educating police, fire, and EMS care providers to recognize crash victims that demand a higher index of suspicion for internal injuries and transport to a trauma center for treatment
- Designing, developing, and validating URGENCY software for faster and smarter emergency medical care for crash victims
- Improving Automatic Crash Notification (ACN) systems for better decisions in triage, transport, and treatment of crash victims
- Improving communications and organization of trauma systems for better care of crash victims

The work of CIREN researchers has contributed to some

recent noteworthy steps toward a Safer America:

- The American College of Emergency Physicians has adopted the following language based, in part, on CIREN research: “The American College of Emergency Physicians (ACEP) supports the development and implementation of programs, policies, legislation, and regulations that promote the use of automatic crash notification (ACN) and intelligent transportation systems (ITS) technologies.” [12]
- General Motors Corporation announced on July 31, 2002, that it would offer an Advanced Automatic Crash Notification system on about 400,000 vehicles in 2003 and more in subsequent years. [13] CIREN researcher Dr. Jeffrey Augenstein, who has contributed to the development of Advanced ACN, was quoted praising this GM decision “This is an extraordinarily significant decision for emergency medicine...It is a breakthrough that will eventually save thousands of lives a year.”
- Ford Motor Company announced on August 3, 2002 it installed enhanced Automatic Crash Notification (ACN) technology in a test fleet of 500 police cars in the Houston area. [14] This is the first deployment of enhanced ACN technology by a major motor vehicle manufacturer. Ford is testing technology that was developed, using CIREN research. The Ford announcement quoted CIREN researcher Dr. Stewart Wang “Delays in medical treatment are directly associated with higher fatality rates and worse outcomes from serious injuries in crashes...This post-crash technology can be especially effective in two cases – rural areas, where a crash is not always quickly seen by passersby and response times are often greater than 1 hour, and urban areas during off-peak driving times.”

Promising Prospects – Researchers at Johns Hopkins University (JHU) Applied Physics Laboratory have conducted an independent evaluation of ACN for NHTSA and reviewed CIREN research on the subject [Augenstein, Cushing, Siegel et al.]. Recently NHTSA published the JHU report that estimated the medical benefits “the ACN system could offer an approximate 20% reduction in fatalities from motor vehicle collisions.” [15]

Figure 5 shows that in more than 10 percent of all the fatal crashes in 2001, it took more than 45 minutes to get 4,013 crash victims to a medical treatment facility, not necessarily a trauma center, that could properly treat potentially fatal injuries. Note that these figures are based only on the 24 percent of all fatalities where times from crash to hospital arrival are reported. Therefore, these figures tend to understate the magnitude of the national problem of getting seriously injured crash victims into operating rooms for definitive medical care within the “Golden Hour.” CIREN data show that, among the Nation’s leading trauma centers, in cases of fatal and potentially serious injuries 1 out of every 4 cases received the benefit of air medical services.

Figure 5.
Fatal Crashes by EMS Times from Crash to Hospital Arrival, FARS 2001

Minutes	Fatal Crashes
≤45 Minutes	5,099
>45 Minutes	4,013
*Unknowns & Dead at Scene	28,683
Totals	37,795

*Includes 23,005 fatalities not taken to a medical treatment facility

CIREN Centers are researching the life-saving potential of improving emergency medical care. The Maryland CIREN Center, for example, has the longest history of leading emergency medical research and education of emergency care providers.

CIREN center researchers [Augenstein, Cushing, Siegel, et al.], the NHTSA, the automotive industry, the wireless communications industry, and emergency medical care providers are continuing to work together to develop, test, and evaluate advanced Automatic Crash Notification (ACN) technologies and URGENCY software to improve emergency rescue of people in serious injury crashes. [22]

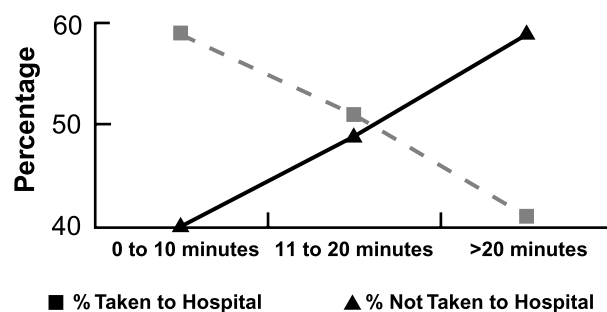
Currently a seriously injured person must wait for a series of time critical steps before receiving optimal medical care:

- Wait for their crash to be noticed,
- Wait until they can be properly located (often difficult along rural roadways),
- Wait for the crash to be reported (often difficult if there is no cell phone available and passersby must travel to a landline phone),
- Wait for police or EMS personnel to travel over land to the crash site,
- Wait for EMS to make a medical assessment and then either take them to a local medical facility or call and wait for an air medical rescue team to warm up the helicopter (about 5 minutes), launch, fly to the crash scene, and find an appropriate landing site,
- Wait for transport to a Level 1 Trauma Center,
- Wait for appropriate tests and diagnoses to receive optimal medical treatment.

CIREN center researchers [Augenstein, Cushing, Siegel, et al.] have been addressing the problems involved in improving the effectiveness and efficiency of triage, transport, and treatment decision-making for crash victims. Figure 6 shows that the time between crash and arrival of emergency medical care is critical to whether or not a seriously injured crash victim is taken to a medical treatment facility for care. The chance of dying at the crash site grows rapidly as time passes waiting for emergency rescue.

In the future, information transmitted, instantly and auto-

Figure 6.
Percent Fatalities: Taken vs. Not Taken by Time Between Crash and EMS Arrival at Scene (All Roads)

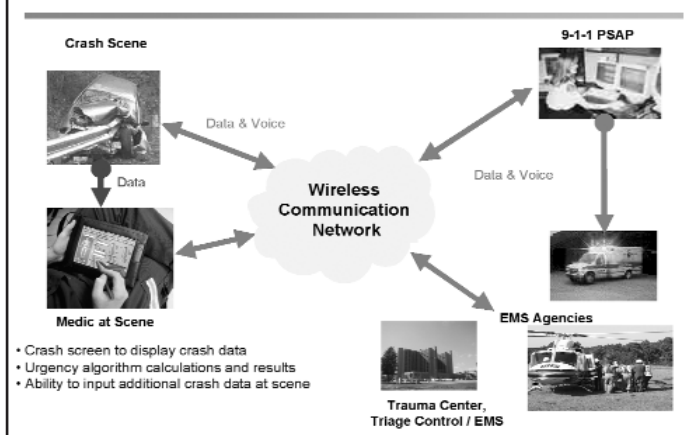


matically, from the scene of the crash is expected to enable faster and smarter emergency rescue decision-making. Timely and valuable information will improve treatment and reduce medical errors in the delivery of pre-hospital and hospital emergency care for life and death decisions:

- **What is the URGENCY level of this crash?**
 - Low Probability (0-10%) of Serious Injury?
 - Moderate Probability (11-49%) of Serious Injury?
 - High (50+%) Probability of Serious Injury?
- **What rescue resources need to be dispatched?**
 - Ambulance (Basic or Advanced Life Support Teams)?
 - Extrication teams and equipment?
 - Helicopter?
 - Trauma team activation?
- **Where should injured people be taken for medical care?**
 - Rural Clinic?
 - Closest Hospital?
 - Trauma Center?

Figure 7

ACN for Lifesaving Emergency Care

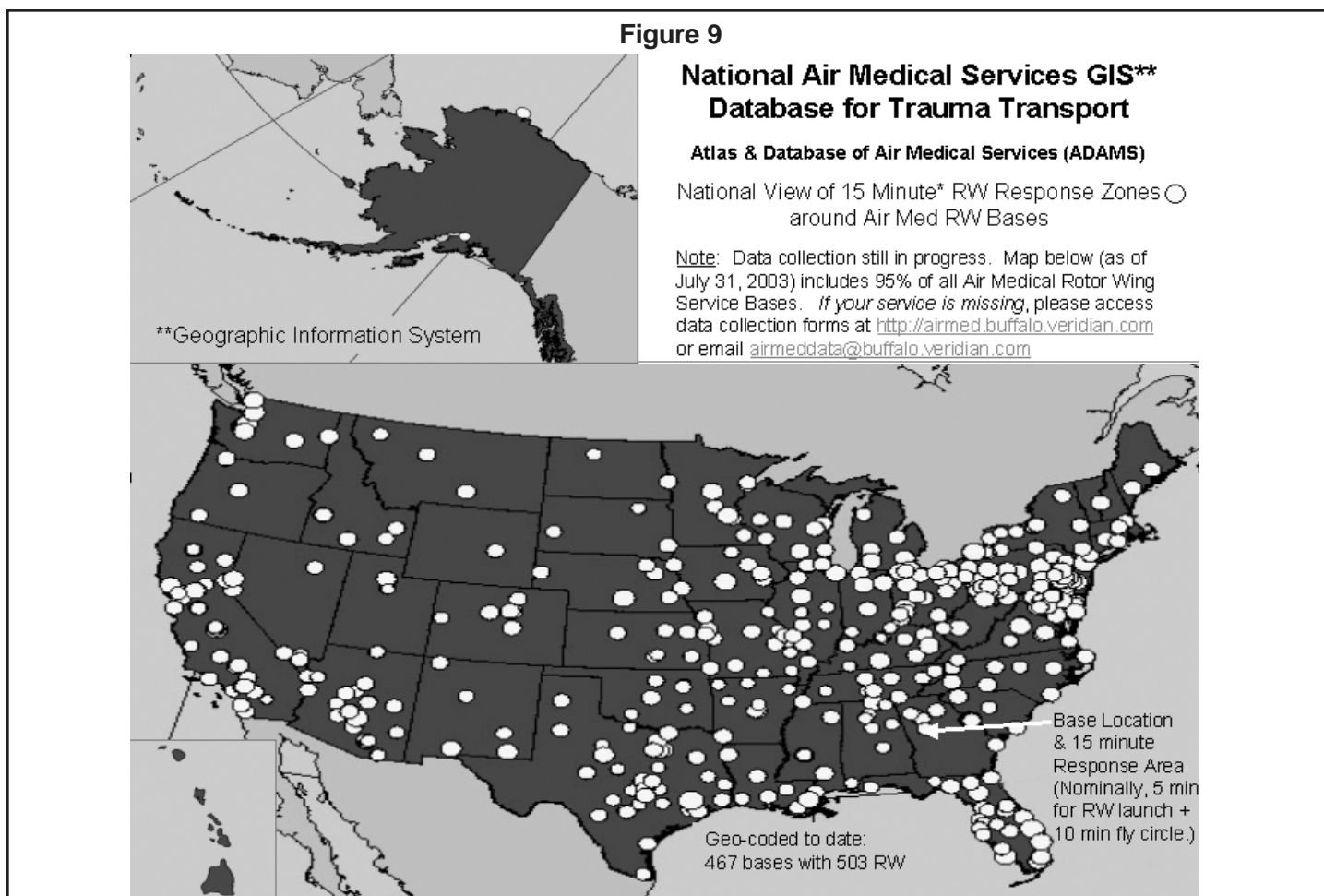
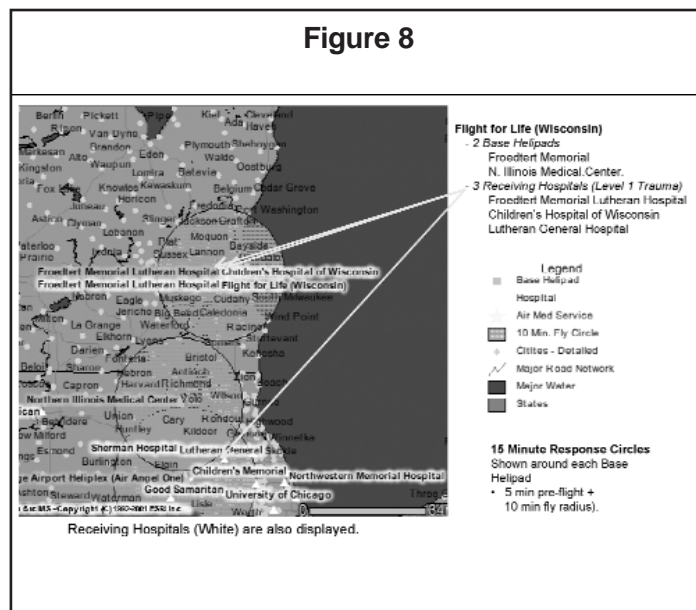


Following and building upon CIREN research, researchers at the Center for Transportation Injury Research (CenTIR) are working with CIREN Center researchers, and the Association of Air Medical Services (AAMS) to develop software to improve emergency dispatch of helicopter rescue teams for people involved in serious injury crashes. [Augenstein, Siegel, Rue, et al.] Dispatch decisions in the future will have the benefit of information from ACN URGENCY and SCENE URGENCY software packages to more effectively and efficiently respond to emergencies. [16] Figure 8 below illustrates this work with respect to the area around the Wisconsin CIREN Center. This work is being performed for use with all air medical services in the nation (see Figure 9).

Seriously injured crash victims will benefit from ACN and URGENCY software being developed in CIREN to expedite and improve emergency medical care:

- Instant and automatic wireless transmission of life-saving information on the occurrence, location, and severity of their crash will be communicated to the appropriate rescue authorities.
- EMS will be able to immediately send the most advanced rescue teams for fastest transport and optimal care.

- Trauma teams of emergency physicians, nurses, neurosurgeons, thoracic and orthopedic surgeons will be simultaneously alerted at the Trauma Center. With timely and pertinent point-of-care information the trauma teams will be able to better prepare to deliver optimal care for incoming patients.



CIREN Center researchers [Augenstein, Siegel, Rue, et al.] are working to update, refine, test and validate URGENCY software. In the future, CIREN research will lead to faster and smarter emergency medical responses to crash victims. CIREN research will help trauma care systems to anticipate injuries based on transmitted crash information, and to find better ways of treatment and rehabilitation of serious crash injuries through continuous performance improvement programs.

To summarize, CIREN is working to fulfill its promise as noted in the National Academy of Sciences (NAS) report, *Reducing the Burden of Injury*:

“CIREN links trauma center clinicians and crash investigators in a nationwide computerized network. This enables engineers to better understand injury-producing mechanisms and to develop better criteria for vehicle safety design, while informing clinicians about emerging injury patterns, and thereby facilitating triage, diagnosis, and treatment of crash injuries.” [17]

The nation’s investment in the CIREN multi-center research program is producing advances in scientific understanding that are being applied to develop safety technologies, safer products, and improved delivery of emergency care. The result will be a safer future for motorists on America’s roads.

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